

# LIFE HISTORY OF THE HICKORY SPIRAL BORER, *AGRILUS ARCUATUS* SAY<sup>1</sup>

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## INTRODUCTION

In the eastern part of the United States there are several species of beetles the larvae and adults of which kill hickory and pecan branches and young trees by girdling or otherwise severing the wood in a vital place. In all cases it seems that the purpose of the insect in doing the injury is to provide itself with dead or dying wood in which to undergo part or all of its development. This paper deals with one of these beetles, which may be called the hickory spiral borer because of the peculiar winding burrow which is the chief injury that it does to trees. In many instances medium-sized branches of bearing trees are killed by this borer, which reduces the crop of nuts, but the principal loss is in the injury to small trees. Young hickory trees in forests, in orchards, and on lawns, and especially in nurseries where seedlings and grafted trees are produced for planting, are liable to attack.

This beetle belongs to the family Buprestidae, the members of which are often called flat-headed borers or metallic wood borers. The term "flat-headed" refers to the broad, flattened front segments of the grubs of some species; and the term "metallic" to the lustrous, metallic colors often displayed by the beetles. The larvae of the many species of *Agrilus*, to which genus the hickory spiral borer belongs, mine in the twigs, stems, roots, and beneath the bark of trunks and branches of numerous kinds of trees and smaller plants. The group includes such familiar pests as the raspberry cane borer (*Agrilus ruficollis* Fab.), the two-lined chestnut borer (*A. bilineatus* Web.), the bronze birch borer (*A. anxius* Gory), and the Pacific oak twig girdler (*A. angelicus* Horn).

## IDENTITY AND DISTRIBUTION

According to W. S. Fisher of the Bureau of Entomology of the United States Department of Agriculture, the forms of *Agrilus* related to *Agrilus arcuatus* are closely allied but not sufficiently well characterized to identify them with certainty. The form which feeds on hickory and pecan is believed to represent only one species, and it is treated in this paper under the name *arcuatus*. Certain varieties of *arcuatus* have been recognized by Le Conte, but they resemble one another so closely that it seems likely that misidentifications have been made. For this reason it does not seem desirable to summarize the literature which has appeared under the name *arcuatus* or its varieties.

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This confusion of names makes it uncertain as to how widely the species here called the hickory spiral borer is distributed, and whether other trees than hickory and pecan are sometimes attacked. There

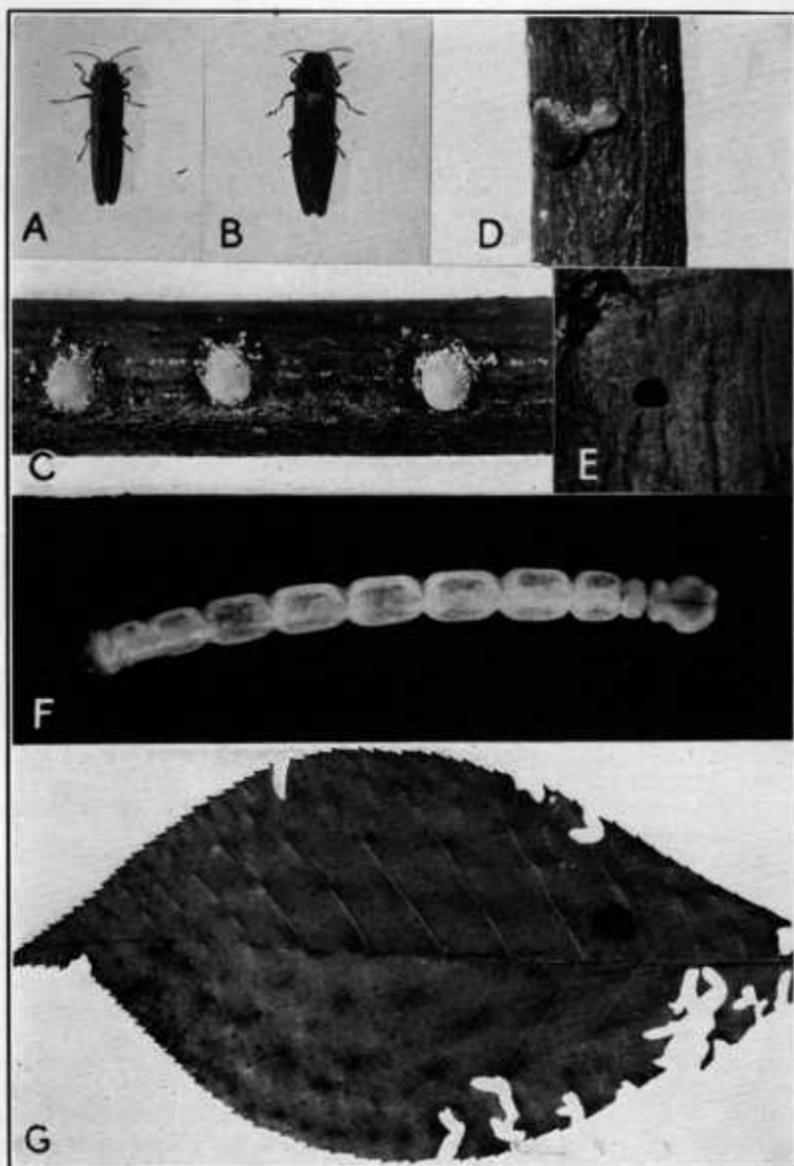


FIG. 1.—Hickory spiral borer: A, male beetle,  $\times 2$ ; B, female beetle,  $\times 2$ ; C, eggs,  $\times 5$ ; D, larva issuing from egg,  $\times 5$  (the eggshell has been removed to the left from over the larva in order to disclose the hatching larva); E, exit hole of beetle,  $\times 2$ ; F, larva,  $\times 4$ ; G, hickory leaf showing feeding marks of the beetle, natural size

seen to be valid records of its occurrence in New York, Pennsylvania, and Virginia. The present writer has collected the insect or has seen specimens of its work at Morgantown, Pickens, French Creek,

Buckhannon, Moorefield, Great Cacapon, and Clarksburg, W. Va.; and at Pulaski, Richmond, Petersburg, and Round Hill, Va. Severed hickory branches, apparently the work of this insect, were found by the writer in the vicinity of Storrs, Conn.

#### NATURE AND EXTENT OF INJURY

The hickory spiral borer hatches from an egg laid on the bark of a twig (fig. 1, C), and lives as a larva in the tree from 22 to 23 months, the period including two entire winters. The larva (fig. 1, F) spends most of the summer burrowing just under the bark, occasionally going deeper into the wood and sometimes following the pith for short distances. Its general course in the wood is downward. Each winter it makes a winding, concentric cut from the inner bark to the heart of the branch or stem, the coils of the thin burrow joining and completely severing the wood except for the bark and sometimes a slender fiber of wood at the heart (fig. 2, C and D). These spiral burrows are in process of making in late autumn, in warm periods in winter, and in the early spring. The first of the two spiral burrows which each insect makes severs a small twig or terminal, and the second severs a larger part of the wood. The portion above the spiral wound dies in the spring before the foliage appears, the injury becoming apparent as the rest of the tree puts forth leaves (fig. 3). Trees and branches from the diameter of a lead pencil to nearly 2 inches in diameter are severed.

The borer is native to the eastern forests where hickory trees abound, and in several instances it has been observed injuring hickory and pecan trees in nurseries and nut-tree orchards in the eastern part of the country. In a nursery at Petersburg, Va., in 1923 and 1924 it did serious damage to seedling and grafted hickories and pecans. In one small block of 5-year-old hickory seedlings in this nursery an hour's search revealed 54 trees with their main stalks recently severed by 2-year-old larvae, and an equal number of twigs and terminals similarly injured by 1-year-old larvae. The trees which the older larvae had severed were set back several years in growth, many of them being practically ruined. Oftentimes such young trees with trunks thus severed will put forth another shoot which will in turn be cut off within a few years. In many instances in localities where the insect is abundant, hickory bushes which have become stunted by frequent pruning will show from 5 to 10 fresh and old wounds. The greatest injury to plantations has been observed near woods in which hickory grows. However, trees in open fields, as well as in the shadow of forest, are liable to attack.

#### LIFE HISTORY

##### THE EGG

The eggs (fig. 1, C) are flat, disklike, somewhat irregular in shape and size, and are glued firmly to the smooth bark of twigs. They resemble quite closely the shield of a small scale insect. When first laid the egg is smooth and pale yellowish green, but before hatching it becomes slightly wrinkled and almost black. The diameter ranges from 0.8 mm. to 1.1 mm. When laid they are partially concealed with a light covering of grains of excrement (fig. 1, C), but the covering soon drops away, and as the egg deepens in color, a

transparent film appears around it. About a dozen eggs collected at different times hatched in 26 and 27 days. When confined in cages the beetles often laid several eggs in a more or less compact group, but in the field not more than one egg was found in a place.

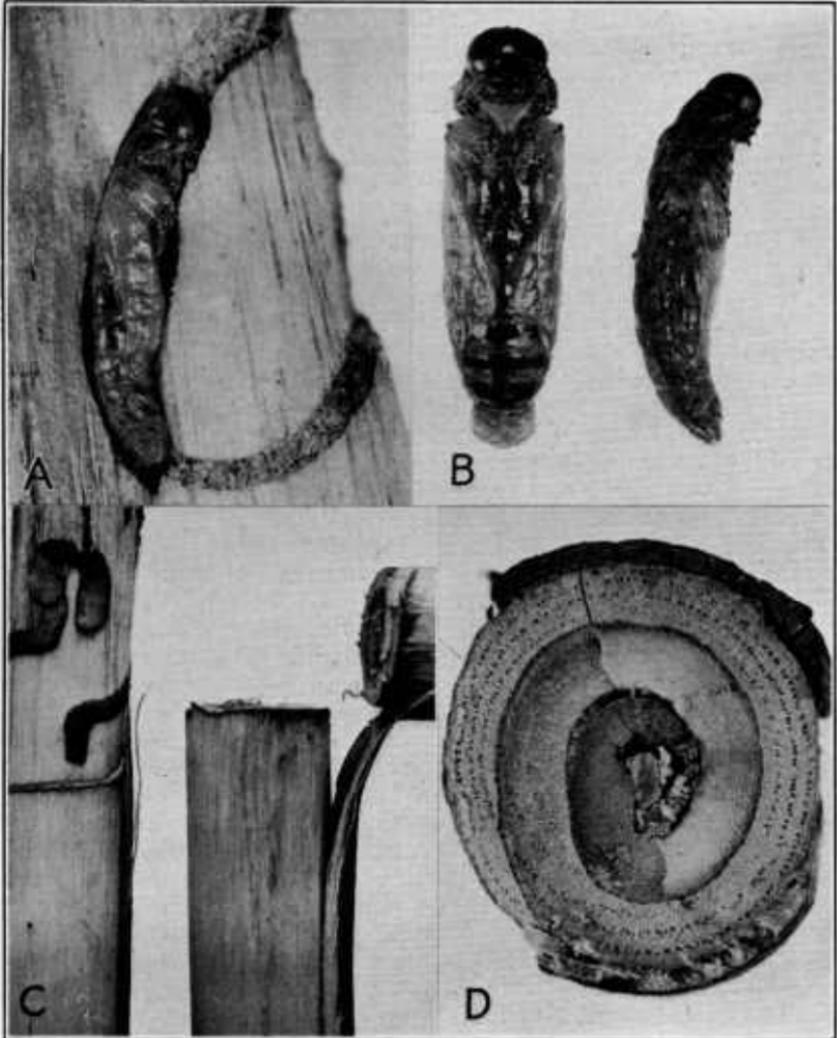


FIG. 2.—Hickory spiral borer: A, pupa in natural position,  $\times 5$ ; B, pupae,  $\times 5$ ; C, hickory stalks showing the burrows; D, hickory branch at point of severance showing spiral girdle of larva,  $\times 2$

#### THE LARVA

The larva (fig. 1, F) is a slender, flat, legless grub, full-grown specimens being from 15 mm. to 20 mm. long and about 2 mm. wide. The color is yellowish white, like that of the wood in which it feeds, except that the small mouth parts and the tail forceps are dark brown or black. It is bare of hairs, save for a small patch of short, whitish bristles at the base of the tail forceps. It is sluggish in movement at all times.

The larva leaves the egg in midsummer, eating its way through the bottom of the egg and directly into the twig. In the twig it makes elongate, threadlike burrows next to the bark and through the wood. Late in autumn it begins a spiral burrow which even-



FIG. 3.—Top of a young hickory tree killed by larvae of the hickory spiral borer

tually severs the wood and kills the terminal above. The spiral burrow may be completed in the autumn, or in the following spring. In either case the larva spends the winter in and about the spiral wound. In all its mining the borer packs the gallery behind with fine wood dust.

With the coming of warm weather the borer works below the severed point, first moving downward for an inch or two in the pith and then tunneling out to the bark. Through the summer it proceeds downward a foot or more, feeding with its back to the inner bark and leaving a shallow but relatively wide burrow packed with wood-colored dust. Late in the season it changes its course abruptly and, with its side to the bark, cuts a thin, symmetrical ring around the branch (fig. 2, C and D). When the first circuit is completed it directs its boring operations spirally inward in the same plane, encircling the stem again, and it continues the spiral burrowing until the heart is reached, when the terminal above will break off with the application of slight force. When this second spiral boring is completed the borer turns upward and eats its way from the heart directly to the bark at a point about half an inch or less above the outer tunnel of the spiral boring (fig. 2, C). By the time it has arrived at the bark, spring has returned, and the larva is then nearly full-grown. It then proceeds to make a crooked burrow a few inches in length just beneath the bark (fig. 2, C) after which it forms a crescent-shaped pupal chamber, the ends of the chamber extending to the bark and the bottom curving toward the heart of the wood (fig. 2, A). Both ends of the chamber are filled with dust, and the larva occupies the somewhat enlarged space between. The larva soon shrinks to about half its former length, and in about a week it changes to the pupal stage.

#### THE PUPA

The pupa (fig. 2, A and B) when first formed is a delicate, white, somewhat curved object, the back being flattish and the underparts bearing outlines of the antennae, wings, and legs. It ranges from 9 to 12 mm. in length, and from 2 to 3 mm. in width. Within a week the eyes begin to darken, and soon thereafter the head, thorax, and other parts of the body change to purplish black, the shades of color deepening until the beetle stage is reached. The pupae are present in May and June, the pupal stage of development lasting about 20 days. The pupa rests in an almost vertical position in a pupal chamber which curves inward and downward from the bark, usually to the heart of the branch. The middle section of the chamber has been enlarged somewhat by the larva for the more comfortable accommodation of its body (fig. 2, A).

#### THE ADULT

The adults (fig. 1, A and B) are dark and slender, the males averaging considerably smaller than the females. The head and thorax of the male are greenish bronze, the elytra are purplish black, and the underparts are brassy; the female is bronze in color effect throughout. The average length of the male is about 8 mm., and that of the female about 10 mm. The beetles appear from May to July, are active only on warm days, and live for about two months. Most of the eggs are deposited in July and the first half of August.

The beetle makes its escape from the pupal chamber through a small D-shaped hole which it gnaws through the bark (fig. 1, E). This hole is usually from 1 to 3 inches above the spiral wound which kills the terminal. The beetles appear from May to July, emergence of individuals in a given locality occurring over a period of at least 25 days, and the season of emergence varying in different localities.

In the summer of 1924 a number of beetles were reared from hickory wood collected at Petersburg, Va., and French Creek, W. Va. Petersburg is approximately 115 miles south of French Creek, and is perhaps 1,400 feet nearer sea level than French Creek. As would be expected, the beetles from the more southerly locality, although belonging to the same generation, transformed and issued first. The beetles reared from the material collected at Petersburg numbered 19, and they issued from May 30 to June 13, the maximum emergence being from May 30 to June 10. The number reared from the material collected at French Creek was 111, and emergence continued from June 23 to July 17, the maximum emergence being from June 24 to June 30. The beetles from Petersburg appeared, on an average, from 20 to 30 days ahead of those from French Creek.

The males appear a few days before the females, and they also die first. In a lot of 10 pairs confined and fed in glass jars, all the females survived the males. Practically all the beetles left the wood in the morning and began to feed soon after they issued, making elongate notches and slits in the edges of the leaves (fig. 1, G). Mating took place within from 12 to 24 hours after emergence, and the first eggs were, as a rule, deposited from 10 days to two weeks later. A female in the act of egg laying was observed to first spend several minutes moving over the bark with the tip of her abdomen pressed against the surface as though searching for a suitable place to deposit her eggs. When such a place was found she devoted about a minute to scraping the spot with her anal tip to smooth or moisten the surface. She then laid an egg and immediately began to move the tip of her body rapidly across and in circles over the egg and the bark immediately surrounding it. This performance lasted 90 seconds, and when it was finished the egg was thinly covered with a transparent liquid, present in slight amount, which glued the egg to the bark.

On July 1, 1924, ten pairs of beetles which had recently issued in rearing jars and which had not begun to oviposit, were found in copulation, and they were confined by pairs in glass jars in an open insectary. They were provided daily with fresh hickory leaves for food and fresh hickory twigs on which to oviposit. A record was kept of the number of eggs laid by each female and the time of death of all individuals.

The 10 females laid 226 eggs, an average of 22.6 each. The greatest number laid by one female was 55, and the smallest number was 2. Eggs were laid during a period of 51 days. Two females of the lot issued from the wood on June 23, first mated on June 24, and lived until August 29, a period of 67 days. The greatest number of eggs laid in one day by the 10 females was 15; this was on July 27. The period of maximum egg production was from July 12 to August 8. The females, on an average, lived about three weeks longer than the males.

#### NATURAL ENEMIES

Several species of hymenopterous parasites were found killing the larvae of the borer, although a relatively small percentage of the insects were parasitized. These Hymenoptera included *Labena apicalis* Cress., determined by R. A. Cushman; and *Monogonogastra agrili* (Ashm.) and *Zatropus* sp. near *nigroaeneus* (Ashm.), determined by S. A. Rohwer.

## METHODS OF CONTROL

It seems probable that the hickory spiral borer may be held in check in nurseries and other plantations of small hickory and pecan trees by dusting or spraying with arsenicals. Beetles kept in cages ate rather freely of the leaves with which they were provided, and they responded to the poison when it was given to them on sprayed foliage. In one instance 20 beetles, equally divided as to sex, were placed in a roomy cage over a live hickory branch that had been sprayed with lead arsenate at a strength of 2 pounds of powdered arsenate to 50 gallons of water. Two days later 9 of the beetles were dead, in 3 days 18 were dead, and the other 2 died in 4 and 5 days, respectively. In a near-by cage set up as a check 50 beetles were confined over an unsprayed branch, and not one of these died during the period of the test. Arsenicals for the control of the borer should be applied from the first to the last of June, according to the locality.

Infested young trees in nurseries and orchards should be pruned of the killed branches and terminals as soon as the leaves develop in the spring. By pruning thus early the insects will be collected with the prunings and may be destroyed by burning. Special care should be taken to cut off the small dead twigs that have been severed by the first-winter larvae. Such twigs should be clipped a few inches below the dead part in order to make sure of getting the borer, which starts to move down the stem at the beginning of warm weather. Twigs containing the 1-year-old larvae need not necessarily be burned, as the borers within them will die when the twigs are cut off. By so disposing of the young borers the more serious damage which they would inflict later may be avoided.